

Significance for AGU

A Model of Earth System Operation as a Basis for Planetary Restoration

Planetary Restoration Action Group
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Significance for policy makers:

- The immediate priority for climate action must be to refreeze the Arctic whose rapid warming has led to a number of tipping points being activated.
- Rapid Arctic warming is causing the dramatic increase in extremes of weather and climate as seen in many countries including the USA.
- These extremes are escalating the damage, loss of life and economic woes around the world, far beyond anything anticipated by IPCC economic models.
- Arctic warming is also accelerating the melting of the Greenland Ice Sheet, with risks of sudden sea level rise from its partial collapse.
- Refreezing the Arctic necessarily involves a type of cooling intervention called Solar Radiation Management (SRM) of which Stratospheric Aerosol Injection (SAI) is a prime example.
- SAI shows the promise of benign intervention sufficiently powerful to refreeze the Arctic.
- SAI, injected at high latitude in late spring and early summer, has minimal risks from ozone depletion and winter warming: the main scientific concerns. With its blanket cooling effect, the only noticeable thing for people below will be gradually lowering temperatures, more normal weather, thicker sea ice lasting longer, and redder sunsets.
- The restoration of sea ice will have major benefits for wildlife and the way of life for indigenous people.
- The slowing of permafrost thaw will help maintain infrastructure dependent on permafrost for its support: buildings, pipelines, etc.
- There is no time to lose: preparation for small-scale deployment of SAI should start immediately whilst validating the method and evaluating its efficacy at full scale. Other cooling methods should be supported as a back-up.
- Achieving net zero emissions by 2050 will not prevent dangerous climate change and sea level rise – the reduction in SO₂ emissions from decarbonisation will make matters worse.
- Emissions reduction, even with large-scale CO₂ removal (CDR), cannot provide the necessary cooling power in the necessarily short timescale for refreezing the Arctic.
- Industries keen to exploit a melting Arctic will have to accept that refreezing the Arctic is in everyone's best interest.
- Peoples in the Arctic and sub-Arctic regions should collaborate in preparations and governance for SAI deployment and authorise such deployment from their own territory.
- In addition to refreezing the Arctic, SRM applied globally at modest cost can cool the planet sufficiently to bring worldwide benefits: saving lives and livelihoods, and protecting ecosystems and economies.
- Achieving net zero heating is more urgent than achieving net zero emissions. Together they underpin the long-term restoration of a safe and sustainable planet for the benefit of future generations.

Significance for scientists:

- Understanding the way the Earth System amplifies Milankovitch signals is vital for staving off climate catastrophe.
- Humanity's huge pulse of greenhouse gases is simulating a peak Milankovitch signal and the Earth System is responding accordingly by amplifying this signal through albedo positive feedback in the Arctic.
- Arctic amplification causes climate change through a chain of effects:
 - Arctic amplification reduces the temperature gradient between the Arctic and tropics, thereby reducing the energy which drives jet stream waves eastward round the planet.
 - The Northern Hemisphere jet streams are meandering more to north and south, and are increasingly liable to get stuck in blocking patterns.
 - This jet stream behaviour is causing a trend towards ever more extreme weather and climate.
- Arctic amplification accelerates sea level rise:
 - The rapid Arctic warming is accelerating the melting of the Greenland Ice Sheet, contributing significantly to sea level rise.
 - The ice sheet is showing signs of disintegration which could cause sudden collapse.
- Arctic amplification is causing accelerated discharge of methane from both land and undersea permafrost, aggravating local and global warming.
- Further weakening of the Atlantic Meridional Overturning Circulation could cause a step change to global ocean circulation.
- Rapid changes in climate and sea level have occurred in the past and would be catastrophic for humanity today.
- To stave off catastrophe, the Arctic needs to be quickly refrozen.
- SAI can be applied quickly, cheaply and benignly to refreeze the Arctic.
- SAI, injected at high latitude in late spring and early summer, has minimal risks from ozone depletion and winter warming. A blanket cooling effect can be produced so there are no immediate effects on particular weather systems such as monsoons.
- The restoration of sea ice will have major benefits for sustaining the Arctic ecosystem with its wildlife and biodiversity.
- SRM applied to cool other regions and the planet generally could restore pre-1980 temperatures by 2050 and achieve the goal of net zero heating.
- Emissions reduction and CDR, though desirable for long-term climate stability, cannot possibly provide the required cooling power on the required timescale, either for refreezing the Arctic or for cooling elsewhere.
- A combination of determined emissions reduction, CDR and methane suppression alongside SRM could, by 2050, bring CO₂e down below 280 ppm, the level it was around 1980. (Without SRM to slow permafrost thaw, methane release could overwhelm all efforts to reduce CO₂e)
- With a combination of measures, the planet could be restored to a safe, sustainable and productive state by 2050.